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Application of new technologies for aquatic plant management

by

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Accurate maps of the aquatic plant distribution within a reservoir or riverine system are essential for an effective aquatic plant control program. However, developing such maps is not an easy task, and managers have problems obtaining good estimates of total plant-infested area and identifying the number of acres affected by each aquatic plant type.

Many operational and management decisions depend on these estimates, including decisions that affect budget requests and contract specifications, selection of priority treatment areas and control methods, and timing of chemical applications to achieve effective control. A proven and cost-effective method for surveying, mapping, inventorying, and analyzing aquatic plant distributions would be highly beneficial to project managers.

Aquatic plant-infested areas are traditionally estimated by visual inspection, or they are delineated and inventoried using aerial photographic-based methods. An experienced resource manager can make fairly reliable estimates of aquatic plant acreage in some areas of the project such as boat ramps or marinas, because the size and distance between certain physical features are known. However, use of this method for large open areas or complex shoreline areas has proved unreliable. Conducting an inventory of the plant-infested area at a project using aerial photographic methods is labor intensive, is generally too expensive to repeat every year, and most importantly, can take months to complete.

Some success has recently been achieved in mapping aquatic plant distributions using digital satellite images or other digital image data. The analysis of these digital images generally requires specialized software and large hard drives for data storage. Further, the acquisition and processing of the images usually takes a long time.

A method for field mapping and computer analysis of aquatic plant distributions, based on Global Positioning System (GPS) and Geographic Information System (GIS) technologies, has been evaluated under the U.S. Army Corps of Engineers' Aquatic Plant Control Research Program in cooperation with the Lake Seminole Resource Management Office, Mobile District.

GPS is a surveying technology that uses small, inexpensive handheld receivers to capture satellite signals. GIS technology is based on the digital manipulation and analysis (processing) of spatial data. When used together, these technologies provide the capability to accurately survey, describe, analyze, and map aquatic plant distributions. The procedure is quick, simple, and is conducted under the direct control of the project manager.

The term "Global Positioning System" refers to a system of 24 radionavigation satellites maintained by the U.S. Department of Defense (DoD). Radionavigation is a method of determining a geographic position (latitude and longitude) on the earth by measuring the travel time of an electromagnetic wave between the transmitter and receiver. The GPS satellites are the transmitters, and the receivers can be positioned anywhere on the ground, in the sea, or in the air (Figure 1). The orbits of the satellites are arranged to provide continuous (24-hour) global coverage.

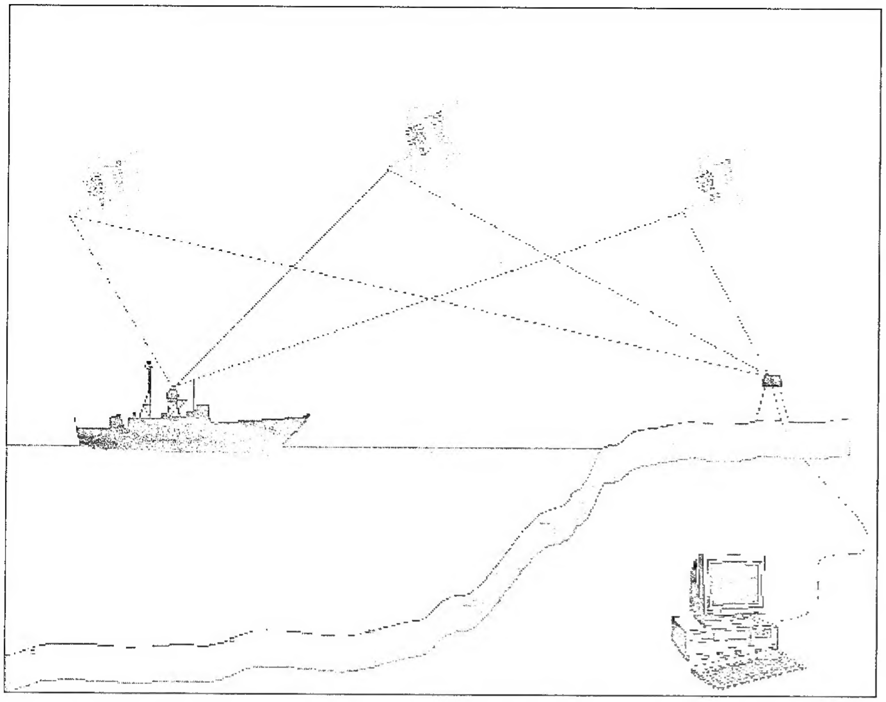

Figure 1. Three basic components of GPS-based surveying: the satellite-based signal transmitters, the mobile or stationary signal receivers, and computer software for calculating real-world coordinates from the signal

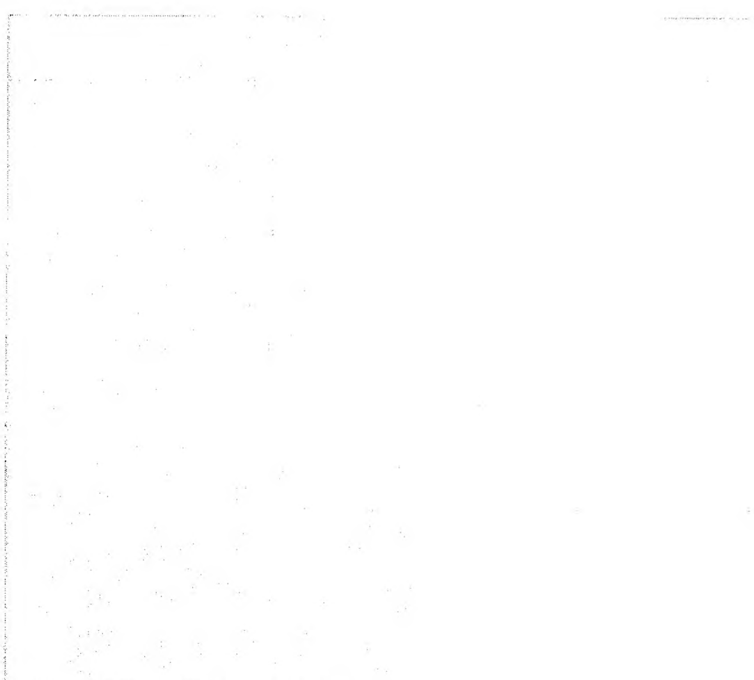

Figure 2. Navigating a GPS-equipped airboat along an aquatic plant bed at Lake Seminole

The small size and low cost of commercially available GPS equipment enable project managers and field personnel to acquire and use them in their daily routines. A GPS receiver properly mounted and used on a boat can continuously record the geographic location (latitude and longitude) of the boat while stationary or in motion. If an airboat moves along the edge of an aquatic plant bed (Figure 2), the location of the edge of the plant bed is captured and stored by the onboard GPS receiver. This basic location information is the beginning of an aquatic plant distribution map.

Techniques for surveying aquatic plant distributions using a GPS receiver mounted on an airboat have been designed and tested by WES in a cooperative effort with the Lake Seminole Resource Management Office.

The basic field equipment needed for GPS-based surveying is shown in Figure 3. The small domed antenna intercepts the satellite signals and transfers them to the receiver for preliminary processing. Figure 4 shows two types of GPS antennas mounted on the cage of an airboat. A six-channel receiver can track up to eight satellites. The antenna and receiver are powered by an external battery pack or 12-volt DC battery while in the field. For setup and testing in the office, a wall outlet or a 12-volt DC power supply can be used.

Preliminary data processing takes place in the receiver, and the data are stored in the data recorder. The recorder includes a keypad and a small digital display, which provide the human interface for the system, as well as some system software. Different types of data recorders are available, with a range of data storage capacities.

Descriptive information related to plants or other features can be

added to the GPS data file as needed using barcode techniques. A barcode wand can be connected to the data recorder for this.

At Lake Seminole, WES employed the barcoding option to add plant type identifiers to the GPS data file. As the airboat navigates the edge of the plant bed, the plant type as well as the location are recorded. The user decides the number of barcodes needed (one for each plant type, open water, etc.) and what the verbal plant description will be (for example, "hydrilla" or "cut grass"). The barcodes themselves are generated by part of the GPS software and printed on a laser printer. A small wand is used to pick up the barcode symbol during the survey and store it with the GPS data (Figure 5). The barcode technique also works well when surveying stationary facilities such as signs, docks, ramps, or camping pads. If the system is not set up for barcoding, the identifiers can be accessed by a menu-driven process on the display screen of the data recorder.

Data stored in the field recorder must be transferred to a computer for additional processing. Each commercial vendor has its own software package that must be provided with the GPS unit. The data transfer from the field recorder to the personal computer is simple. A cable links the field recorder to a serial (communications) port of the computer, and easy-to-use software takes care of the transfer. The processing of the data into real-world (geographic) coordinates is a menu-guided procedure. The result of data processing is a set of real-world (X,Y) coordinates tracking the position of the receiver during the survey and information (from the barcode) identifying or describing the important features at the survey points.

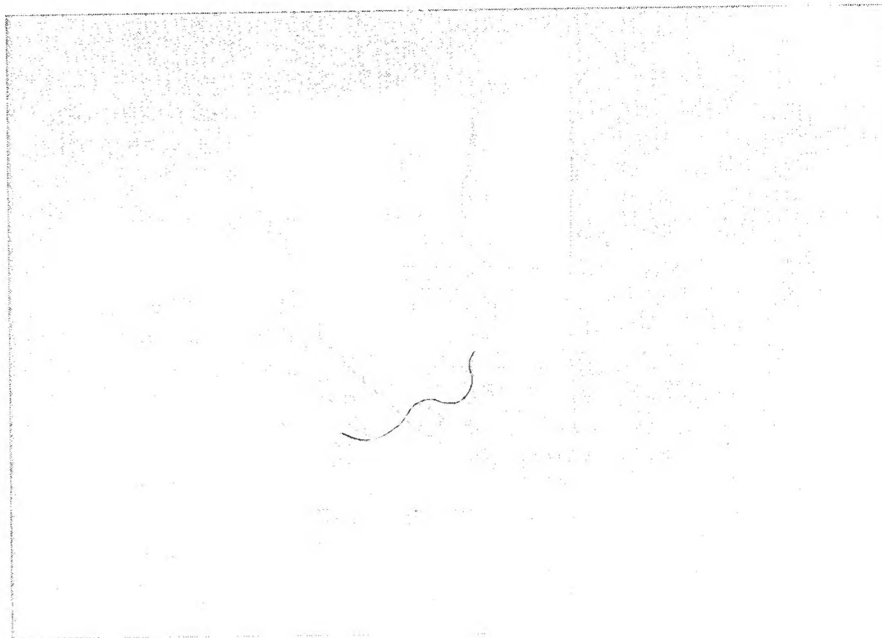

Figure 3. Typical GPS equipment needed for field surveying

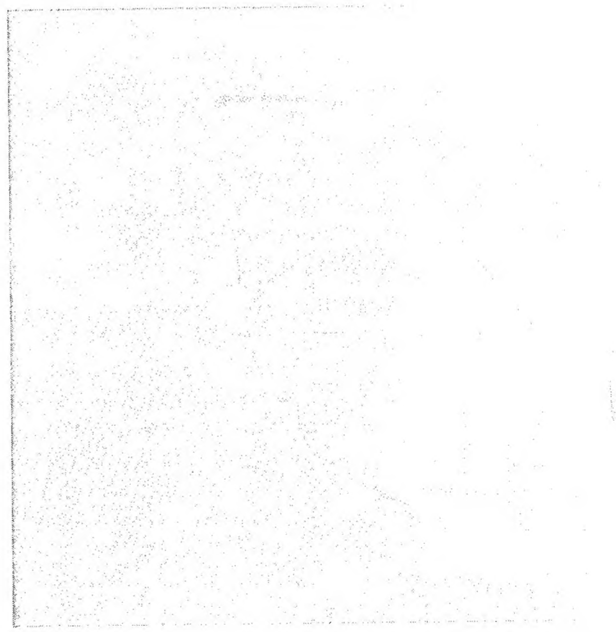

Figure 4. Two types of GPS antennas mounted on the cage of an airboat

Most GPS softwares allow the transfer of processed (real-world) data to other software packages such as a Geographic Information System (Figure 6). GIS is a technology for processing and analyzing digital geographic spatial data. "Digital" means the data are in machine-readable format. The term "processing and analyzing" encompasses almost any set of computer functions. "Geographic" means that the data are referenced to the earth. "Spatial" refers to the data model space. That is, the data are derived from and represent the physical shape, size, form, and substance of something that is real in the landscape, watershed, or reservoir.

The GIS will accept a string of processed coordinates from the

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22UB06 polygonum	22UB07 hyacinths
22UB09 banana_lily	22UBOA cow_lily
22UBOC water_primrose	22UBOD alligator_weed
22UBOF pennywort	22UBOG hydrilla
REPEAT LAST FEATURE	FEATURE OFF

Figure 5. Barcodes are developed by the user as needed and stored in the field recorder to describe important features as they are surveyed

Figure 6. GIS accepts the surveyed data from the GPS and allows the manager to develop digital and hard-copy maps, conduct plant inventories, and compare the aquatic plant distributions to other resources or facilities at the project

GPS software and reformat the coordinates into a digital map of aquatic plant distribution. Descriptive or quantitative information (plant type, density, etc.) is linked directly to this digital aquatic plant map.

The digital map can be processed or analyzed in a variety of ways to support the planning and execution of a control program. Project managers can use the GIS to easily determine the total acreage of aquatic plant beds of each plant type, to calculate the length of the plant-water interface, or to compute the distance of a nuisance plant bed from critical habitat or public access points.

As the aquatic plant control operation is carried out, additional information can be added to the GIS database to document the type of control procedures used. For instance, the geographic limits of a herbicidal application would be entered into the database and documented by the date of application, the chemical and application rate, the contractor, and the total amount of chemical applied during the treatment.

One of the great benefits of building and maintaining the GIS database is the capability to easily compare several years of aquatic plant distribution data. Over time, the patterns of plant spread and decline can be mapped, analyzed, and directly compared to the known limits of the herbicide applications. Using these analysis techniques, the results or effectiveness of the herbicide treatment can be accurately documented and stored in the database. This capability provides a new and powerful planning tool for managers.

A database with only the boundaries of aquatic plant beds depicted would be of limited use in designing an effective control program. In fact, the location and extent of the plant beds is only one factor that must be considered

in scheduling control and selecting the type of control.

The distribution of the aquatic plant infestations is most meaningful when compared against the other physical and cultural resources of the project (Figure 7). For aquatic plant management applications, a GIS database should include, among other things, the shoreline, public access points (boat ramps, campgrounds, and picnic areas), small boat channels, locations of any threatened or endangered species, and critical habitats.

Several factors affect the horizontal accuracy achieved using GPS surveying techniques. Among these factors are the use of a local base station, degradation of the satellite signal by DoD, and local environmental conditions.

A base station is a second GPS receiver, set up over a fixed point of known location, for collecting the same satellite signals as the mobile receiver. Figure 8 shows the base station at Lake Seminole. The best location for a base station is a bench mark. Bench marks are rarely convenient, so any point with good vertical location that has been carefully surveyed can serve as a base station location. The satellite signal record captured by the base station is used to improve the horizontal positioning of mobile receivers. Many mobile receivers can be serviced by a single base station.

Mobile receivers operated without a base station typically achieve horizontal positional accuracies of 12 to 40 meters, depending on local environmental conditions and satellite signal degradation. The horizontal position of a mobile receiver operated simultaneously with a base station can be corrected to 1- to 5-meter accuracies. The newest GPS systems on the market offer options that can achieve

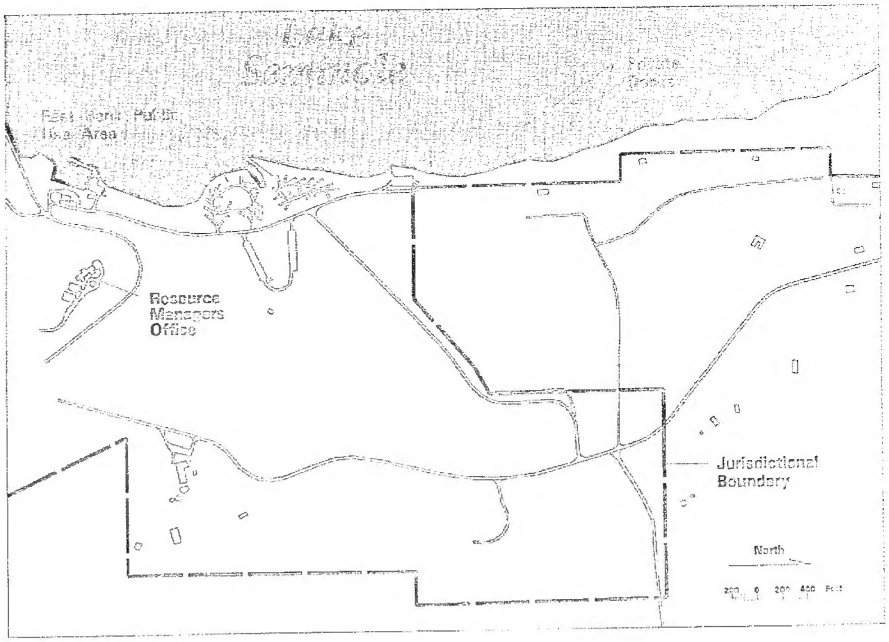

Figure 7. Lake Seminole GIS database includes features other than aquatic plants, such as the shoreline, public use areas, private docks, and roads

sub-meter horizontal accuracies under the right conditions.

A second factor affecting positional accuracy is the quality of the satellite signal itself. The DoD can deliberately degrade the satellite signal, causing inaccurate horizontal position calculations. This DoD practice is called "selective availability." Fortunately, the use of a base station can almost completely negate the effect of the most common signal degradation method.

Local environmental conditions can interfere with signal reception. Heavy tree canopy, large buildings, or hills may obstruct the sky. Disturbance of the earth's atmosphere and ionosphere may cause delays in the signal which translate into positional errors.

GPS and GIS technologies are revolutionizing surveying, mapping, monitoring, and resource management activities worldwide. These two technologies, properly integrated, provide low-cost surveying, mapping, and resource analysis tools. These tools have great potential to support field

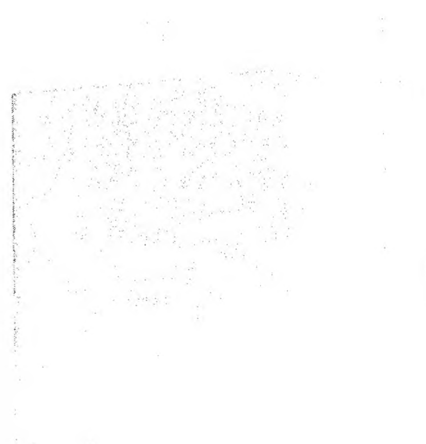

Figure 8. Base station at Lake Seminole was set up near the boat shelter. The antenna is mounted on a range pole extending above the shelter

personnel and managers as they strive to meet the challenges of ecologically sound multiple-use management.

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Aquatic Plant Bulletin Board System (APBBS)

The APBBS is an electronic bulletin board system managed under the Center for Aquatic Plant Research and Technology (CAPRT) at the Waterways Experiment Station. Development of the APBBS was conducted through the Corps of Engineers' Aquatic Plant Control Research Program. The APBBS provides users with access to an abundance of aquatic plant information and to other Corps aquatic plant management personnel.

Requirements for accessing the APBBS are a personal computer, a modem, a telephone line, and a communications software package. The APBBS telephone number is (601) 634-3018. To communicate with the APBBS, your computer's communication software must be set to the following:

Speed = 28,800 baud or less
Data bits = 8
Parity = None
Stop bits = 1
ANSI BBS emulation

To log on, have your communications software dial the APBBS telephone number. Once your computer is connected, the APBBS will ask for your name and password. New users will be asked to answer several additional questions to register. Ontime usage is limited to 60 minutes per day.

The APBBS provides an opportunity for users to discuss ongoing problems and solutions; upload and download files; obtain a calendar of events for meetings, seminars, and workshops; and access the WES Technical Library. In addition, the APBBS provides the names and telephone numbers of WES aquatic plant research personnel, Field Review Group members, and points of contact for aquatic plant operations at Corps divisions and districts.

If you have problems, questions, suggestions, or comments concerning the APBBS, please contact Carolyn Schneider (System Operator), (601) 634-3657, or Bob Gunkel (Assistant Director, CAPRT), (601) 634-3722.

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This issue describes the application of new technologies for field mapping of aquatic plant infestations. These technologies can be directed to the challenges of ecologically sound project operations and resource management.

AQUATIC PLANT CONTROL RESEARCH PROGRAM

This bulletin is published in accordance with AR 25-30 as one of the information dissemination functions of the Environmental Laboratory of the Waterways Experiment Station. It is principally intended to be a forum whereby information pertaining to and resulting from the Corps of Engineers' nationwide Aquatic Plant Control Research Program (APCRP) can be rapidly and widely disseminated to Corps District and Division offices and other Federal and State agencies, universities, research institutes, corporations, and individuals. Contributions are solicited, but should be relevant to the management of aquatic plants, providing tools and techniques for the control of problem aquatic plant infestations in the Nation's waterways. These management methods must be effective, economical, and environmentally compatible. The contents of this bulletin are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such products. This bulletin will be issued on an irregular basis as dictated by the quantity and importance of information to be disseminated. Communications are welcomed and should be addressed to the Environmental Laboratory, ATTN: J. L. Decell, U.S. Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, or call (601) 634-3494.

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